THE NEW METHOD

PROPOS'D by

Sign^r *DOROTHEO ALIMARI*,

Profeſſor of Mathematicks at *Venice*,

TO DISCOVER the

LONGITUDE.

To which are added,
Proper FIGURES of ſome Inſtruments which he
hath Invented for that Purpoſe:
With a plain DESCRIPTION of Them.

Humbly Preſented to the
Right Honourable the LORDS, and Others,
Appointed by Act of Parliament COMMISSIONERS,
for Examining and Judging of PROPOSALS for
Finding the LONGITUDE.

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Math vol 2

TO

The Right Honourable THOMAS *Earl of* Pembroke *and* Montgomery.
The Right Reverend Father in God PHILIP *Lord Biſhop of* Hereford.
The Right Reverend Father in God GEORGE *Lord Biſhop of* Briſtol.
The Right Honourable THOMAS *Lord* TREVOR, *Lord Chief Juſtice of the Common-Pleas.*
The Admirals of the Red, White and Blue Squadrons.
The Firſt Commiſſioner of the Admiralty.
The Firſt Commiſſioner of the Navy.
The Firſt Commiſſioner of Trade.
The Maſter of Trinity-Houſe.
The Honourable Sir THOMAS HANMER, *Baronet, Speaker of the Honourable Houſe of Commons.*
The Honourable General STANHOPE.
The Honourable FRANCIS ROBERTS, *Eſq;*
Sir ISAAC NEWTON, *Preſident of the Royal Society.*
WILLIAM LOWNDES, *Eſq;*
WILLIAM CLAYTON, *Eſq;*
Mr. JOHN FLAMSTEAD, *Aſtronomer Royal.*
Dr. EDMUND HALLEY, *Savilian Profeſſor of Geometry.*
Mr. JOHN KEILL, *Savilian Profeſſor of Aſtronomy.*
Mr. SANDERSON, *Lucaſian Profeſſor of the Mathematicks.*
Mr. ROGER COTES, *Plumian Profeſſor of Aſtronomy.*

Commiſſioners appointed by Act of Parliament for the Diſcovery of the
LONGITUDE.

My LORDS and GENTLEMEN,

UPON the Encouragement of the late Act of Parliament, I preſume Humbly to lay before your Honours *A Method of Diſcovering the Longitude* *at Sea with great Exactneſs.* 'Tis the Product of much Study, Time, and Experiment; and what will, I hope, fully Anſwer the End. The Deſcription here given of the Inſtrument is ſo plain, that after this, a good Workman may eaſily make it. Beſides, whenever I have Your Commands, the Inſtrument made by the Author's own immediate Direction, and what he hath made frequent Trials of, with Succeſs, ſhall be laid before Your Honours. 'Tis a great Pleaſure to Me, thus to lay the Fruits of ſo long Labours before Perſons, upon whoſe Judgment I can with ſo much Confidence rely; and upon whoſe Juſtice I may depend, with no leſs Security.

I am,

My LORDS *and* GENTLEMEN,

Your Honours moſt Obedient,

Humble Servant,

SEBASTIANO RICCI.

St. James's-Square,
Auguſt the 31ſt,
MDCCXIV.

Fundamenta quibus inixus DOROTHEUS ALIMARI, inter Mathematicos minimus Longitudinem Civitatum, & locorum Univerſi terraquei Globi aſſequi poſſe contendit.

Primum, *FUndamentum conſiſtit in determinatione Primi alicujus Meridiani, qui ex omnibus terraquei Globi partibus comprehendi, atque diſtingui poſſit, quod hucuſq; ab alijs aptè factum non videtur: Ut hoc eleganter fieri queat, non melius Auctor agere ſe poſſe credidit, quam ſi ad datum aliquem Meridianum ad placitum eligibilem exactiſſimæ conderentur Ephemerides Solarium motuum in Longitudine, & Declinatione ad Gradus, Minuta, atq; Secunda, ut ex eis ad quodcumque tempus haberi poſſet vera Solis Longitudo, & Declinatio, ac utriuſ-*

DOROTHEUS ALIMARI, *Profeſſor of the* Mathematicks, *propoſes to find out the* Longitude *of all Cities, and Places of the Terreſtrial Globe by the following Method.*

First, SUCH a Meridian muſt be pitch'd upon as may be diſtinguiſhed from all other Parts of the Globe, which doth not ſeem to have been hitherto conveniently done ; and this the Author believes cannot be better perform'd, than by making exact Ephemerides of the Motion of the Sun in its Longitude and Declination, as to Degrees, Minutes, and Seconds, for any Meridian that ſhall be pitch'd upon, that thereby the true Longitude, and Declination of the Sun plac'd in its firſt Meridian, and the Diurnal Motion of both may at

utriuſque motus diurnus, Sole conſtituto in ipſo Meridiano primo. Propterea Ephemerides prædictas condidit Auctor ipſe modo ſuprà enunciato ad Meridianum Inſulæ Ferreæ, quem ſibi placuit pro Archimeridiano conſtituere.

Secundum, *Auctoris fundamentum ponitur in diligentiſſimâ obſervatione veræ altitudinis Solis ſupra Orizontale planum in gradibus, minutis, atque ſecundis, quam facere ſe poſſe confidit (excepto tamen magnarum Procellarum tempore) non obſtante conſueto navis, & maritimorum fluctuum motu, & agitatione, ope unius Inſtrumenti ſimplicis ſtructuræ, tenoris ejuſmodi.*

Habeatur Cylindrus, ſeu Tubus externæ, & internæ, conſtructionis perfectiſſimæ craſſitiei unius unciæ circiter, internè vacuus. Hic ex aurichalco, ære, buxo, vel aliâ quâvis duriori materiâ conſtrui poteſt. Ejus verò Longitudo, quantò major fuerit, tantò melior erit, commoda verò creditur ſi fuerit unciarum ſexaginta circiter: in ejuſque ſuperficie per Longum diligentiſſimè adnotabuntur unciæ ſingulæ.

In ſuperiori, ſeu verticali parte ipſius Tubi, ſeu Cylindri ad angulos adamuſſim rectos ſtatuendus eſt circulus

at any time be obtain'd. And therefore he hath made ſuch Ephemerides, calculated to the Meridian of the Iſland of *Ferro*, which he choſe for his firſt Meridian.

Secondly, The Degrees, Minutes, and Seconds of the true Altitude of the Sun, muſt be very carefully and exactly obſerv'd; which he is confident [except in very great Storms] may be done, notwithſtanding the uſual Motion, and Agitation of the Sea, with this plain Inſtrument, *viz.*

Get an Hollow Cylinder, or Tube, one Inch thick, exactly made either of Braſs, Copper, Box, or of any hard Material; and the longer it is the better; however it is thought, that one of about 60 Inches wou'd be convenient. The Inches ought to be carefully mark'd upon the Outſide.

A flat Braſs Circle muſt be plac'd exactly at right Angles on the Top of this Tube. The Diameter of this Circle *culus æreus planus, cujus diameter ſit unciarum novem, quorum unam occupabit Cylindri ipſius craſſities; reſiduæ Diametri ejuſdem circuli partes, quæ erunt unciarum quatuor, diviſæ intelligantur in partes* 100000, *ſic ut (iis vicem gnomonis continui præſtantibus) gnomonis ipſius Longitudo ſinum totum repræſentet: In ipſius autem circuli centro ſtatuendum eſt foramen æquale foramini ipſius tubi: Immittatur deinde ipſi tubo funis, ſeu chorda tantæ craſſitiei, ut foramen ipſum ad unguem impleat, & quantum oportuerit ultrà ſe extendat: ejus Chordæ pars, quæ fuerit ex parte memorati circuli, tripedali, vel quadrupedali fulcro ſuſpendatur & alligetur; inferiori verò appendatur Globus æreus ſacculo incluſus ponderis Librarum* 50; *erigatur deinde quadrupedale fulcrum, itàque firmiter ſtatuatur, ut inſtrumentum, cum Globo ipſo libero in aere conſtituatur; fiet enim, ut (premente Globi ipſius pondere Chordam) ille continuò ſtet Horizonti perpendicularis, & per conſequens circulus æreus prædictus ſit plano Horizontali parallelus, non obſtante aliquo navis motu: Nam licèt perpendiculum ipſum ob eundem motum ſitum mutaret, funis tamen continuò Horizonti perpendicularis haberetur.*

Inſtrumento ipſo tali pacto conſtituto,

Circle muſt be of 9 Inches, whereof one is taken up by the Thickneſs of the Tube. The remaining Parts of the Diameter of the Circle, which ſhall be Four Inches,ought to be ſuppos'd to be divided into 100000 Parts ſo that (they ſerving as a continued Gnomon) the Length of the Gnomon may repreſent the Radius. A Hole muſt be made in the Center of the Circle exactly of the ſame Bigneſs with that of the Tube. A Line, or Chord, of ſuch a Thickneſs, as may exactly fill up that Hole muſt be paſs'd through it, and extended as ſhall be needful. Let that part of the Chord towards the ſaid Circle be ſuſpended upon a Three, or Four Legg'd Frame. Hang on the lower Part a Braſs Ball in a Bag of 50 Pounds Weight; then raiſe up and fix the ſaid Frame ſo, that the Inſtrument and Ball hang freely in the Air; the Weight of the Ball preſſing the Chord, that Ball ſhall always be perpendicular to the Horizon; and conſequently the ſaid Braſs Circle, notwithſtanding the Motion of the Ship, Parallel to the Horizontal Plane. For tho' this Perpendicular by ſuch a Motion ſhould alter its Site, the Chord will always remain Perpendicular to the Horizon.

Such an Inſtrument being made, when

to, incidentibus Solaribus radiis in ſuperiorem Circuli partem, ejuſdem umbra in inferiorem projicietur, ejuſque minor Longitudo in parte Cylindri Soli obverſa ſignabitur. Ut autem hæc adamuſſim haberi queat in partibus, quarum gnomon, ut ſupra, eſt 100000, *poſſibilitatem præſtabit nobile Trochleæ artificium, quod à nobis hic non deſcribitur, cum apud Profeſſores notæ credatur inventionis. Hoc etiam commodi ex hoc noſtro Inſtrumento accedet, ut quomodocumque ipſum ſit Soli obverſum, eadem ſemper unico temporis momento accidet umbræ Longitudo.*

Cum Solis altitudo ſuprà Horizontale planum fuerit præciſè graduum 45, *ejus umbra erit ad unguem partium* 100000, *& propterea gnomoni æqualis, unciarum ſcilicet quatuor: excedente vero Solari Altitudine gradum quadrageſimum quintum (licet æquè, & bene uſque ad octogeſimum Solaris Altitudinis gradum eadem regula inſervire poſſet) nos tamen, ad evitandam umbræ Longitudinem non bene diſtinctam, præſtare putamus in ſuperficie ipſius ærei Globi gnomonem unum, vel plures ad angulos rectos conſtitutos habere, Longitudinis unciæ unius, in Centro circuli, ſeu circulorum, quorum ſemidiameter gnomonis ipſius Longitudini ſit æqualis; ipſorum enim gnomonum modo, quo*

ſuprà

when the Rays of the Sun fall on the upper Part of the Circle, the Shadow of it will be caſt below; and its leſſer Longitude will appear on that Part of the Cylinder which is toward the Sun. A noble Kind of Trochlea, which I do not deſcribe here, becauſe already ſufficiently known, will make it poſſible to take this in the 100000 Parts whereof we have ſaid the Gnomon conſiſts. This Advantage will reſult from that Inſtrument, that which way ſoever it is turn'd to the Sun, you'll ſee in an Inſtant the Length of the Shadow.

When the Altitude of the Sun above the Horizontal Plane ſhall be exactly 45 Degrees, its Shadow ſhall alſo be exactly 100000 Parts, and therefore equal to the Gnomon, (*viz.*) of 4 Inches. But if the Sun's Altitude is more than 45 Degrees, (tho' the ſame Rule may as well hold for the Sun's Altitude even to 80 Degrees) yet becauſe the Length of the Shadow may not be plain, it is thought better to have on the Superficies of the Braſs Ball, one, or more Gnomons plac'd at right Angles, of an Inch long, in the Center of the Circle or Circles, whoſe Semidiameter may be equal to the Length of the Gnomon it ſelf; the Shadow of thoſe Gnomons being meaſur'd as

above,

ſuprà, dimenſa umbra, eaque quadruplicata tangentem complementi Solaris Altitudinis æquabit; quam ob rem in Tabulis ipſa tangens perquiſita dabit præciſam Solis Altitudinem in Gradibus, Minutis, atque Secundis, quo caſu ſuperflua Cylindri Longitudo reſecari poſſet.

Solis Altitudine adinventâ, ut ſuprà, vel alio quocumque pacto, ſi ejus obſervatio facta ſit in Meridianâ verâ Mundi Lineâ, ſitque cognita Poli, vel Æquatoris Altitudo in gradibus, minutis, atque ſecundis, cum qua haberi poteſt vera Solis Longitudo in Zodiaco, *facili negotio emerget & Solis Declinatio in Gradibus, Minutis, atque Secundis: Verùm ſi prædicta nota non habeatur, ex Triplici Solis obſervatione eâdem die factâ, Diagramma, ſeu ſimilis figura componatur, per quam (ceu in ſpeculo) unico temporis momento patefiunt vera Meridiana Linea, Magnetica Declinatio, Latitudo ortiva & occidua Solis, ejuſdemque Altitudo Meridiana, Declinatio ab Æquatore, arcus ſemidiurnus, & ſemi-nocturnus, horarium tempus à momento obſervationis ad meridiem, vel ortum, aut occaſum Solis in ipſo obſervationis loco, unà ſimul cum Æquatoris, atque Poli elevatione: quæ omnia ſi quis in gradibus, minutis, atque ſecundis habere geſtiat, paucorum*

trian-

above, and quadrupl'd, ſhall equal the Tangent of the Complement of the Altitude of the Sun; and therefore the ſaid Tangent being look'd in proper Tables, ſhall ſhew the exact Altitude of the Sun in Degrees, Minutes, and Seconds, in which caſe the ſuperfluous Length of the Cylinder may be reſcinded.

The Sun's Altitude being found in the aforeſaid, or any other Method, (provided the Obſervation be made in the true Meridian Line of the World) and the Altitude of the Pole, or Equator known in Degrees, Minutes, and Seconds, *with which may be had the true Longitude of the Sun in the Zodiack*; the Declination may eaſily be found in Degrees, Minutes, and Seconds: But if this doth not appear, let a Diagram, or Figure like it, be contriv'd out of the three Obſervations of the Sun made that Day, whereby, as in a Glaſs, you may eaſily diſcover, in a Moment, the true Meridian Line, the Variation of the Compaſs, the Latitude of the Sun's Riſing and Setting, its Meridian Altitude, Declination from the Æquator; the Semidiurnal and Seminocturnal Arch, the Hour from the Moment of the Obſervation at the Meridian, Riſing, and Setting of the Sun in the Place of the Obſervation, together with the Elevation of

the

triangulorum ope, & modico temporis interſtitio per regulas ab ipſo auctore traditas aſſequi valebit.

Ex compertis declinatione Solis, & arcu ſemidiurno ad tempus obſervationis, docet auctor Longitudinis veræ Solis inventionem in Zodiaco, ſive de tempore, quo Sol in Meridiano, ſive in Horizonte Loci obſervationis reperitur, quâ Collatâ cum eâ, quam Sol in Archi-meridiano habere comperitur, reſultat illicò inter utramque Solis Longitudinem differentia, per quam, & motum diurnum ejuſdem (aureâ juvante regulâ) invenitur arcus Æquatoris interceptus inter Archi-meridianum ipſum, & Meridianum Loci obſervationis, vel inter Archi-meridianum ipſum & circulum declinationis Solis in Horizonte ortivo, vel occiduo, aut ubilibet poſiti, quibus reſpectivè caſibus opportunæ enunciantur regulæ veræ Loci obſervationis Longitudinis nanciſcendæ.

Quod ope Solaris Longitudinis fieri auctor demonſtravit, id pariter per aſcenſiones ejuſdem rectas, & brevius (ali-

the Æquator, and the Pole; and if any deſire to have all this in Degrees, Minutes, and Seconds, it may be attain'd by the help of ſome few Triangles, and in a ſhort Time by proper Rules preſcrib'd by the Author.

From the Declination of the Sun, and Semidiurnal Arch being found at the time of Obſervation, the Author ſhews the true Longitude of the Sun in the Zodiack; or the Time, wherein the Sun is found in the Meridian, or in the Horizon of the Place of Obſervation, which being compar'd with that, which the Sun is found to have in the firſt Meridian, a difference reſults from theſe two Longitudes of the Sun; whereby, and by its Diurnal Motion, you find by the Golden Rule the Arch of the Æquator intercepted between the firſt Meridian, and the Meridian of the Place of Obſervation; or between the firſt Meridian it ſelf, and the Circle of the Declination of the Riſing and Setting of the Sun in the Horizon, or elſewhere, in all which Caſes there are proper Rules to diſcover the Longitude of the Place, where the Obſervation is made.

What the Author hath demonſtrated may be done by the help of the Sun's Longitude, he ſhews by proper Rules

(aliquando) per obſervatam tantum declinationem ipſius Solis fieri poſſe per opportuna præcepta oſtendit.

Ne verò imperitiores Nautæ Longitudinem locorum aſſequi cogantur per quotidianas obſervationes, ut ſuprà faciendas, innuit Auctor modum inſtrumenti organici portatilis ad horologij normam componendi, in cujus facie præter conſuetas horas, minuta, atque ſecunda, licet intueri circulum diviſum in partes 360, per quem Æquator repreſentatur; cujus inſtrumenti beneficio ad quodcumque temporis momentum deprehendi poteſt verus locus Solis in Æquatore, & proinde ejus vera diſtantia ab Archimeridiano; Ita enim indicis ipſius inſtrumenti temperatus eſt curſus, ut quo tempore Sol in Archimeridiano comperitur, index ipſe ad Meridianum Horologij præciſè deveniat; hinc fit, ut ſi quâvis horâ obſervetur diſtantia indicis ipſius à Meridiano ejuſdem, illicò reſultet, & diſtantia Solis Æquatoria à Meridiano primo, ex cujus deinde notitiâ facili negotio Longitudinis veræ loci ab auctore docetur inquiſitio.

Quod ſi per Navis agitationem, aeris alterationem, aut aliter inſtrumentum ipſum variationem, ſeù alterationem aliquam ſubire videatur, docetur quomodo per novam obſervationem ad priſtinum Locum reſtitui queat.

Rules, that it may alſo be done by the right Aſcenſions, and ſometimes in a ſhorter Way by the Declination of the Sun.

But that unskilful Seamen may not be oblig'd to find out the Longitude by the daily Obſervations before mention'd, the Author propoſes a portable Inſtrument, in the nature of a Clock, upon whoſe Dial, beſides the Hours, Minutes, and Seconds, there is to be a Circle divided into 360 Parts, repreſenting the Æquator; by which Inſtrument you may, at any Time, find out in what part of the Æquator the Sun is, and conſequently the true Diſtance from the firſt Meridian; the Motion of this Inſtrument is ſo contriv'd, that at the Time the Sun is in the firſt Meridian, the Index exactly points to the Meridian of the Clock: Hence it follows, that at whatſoever Hour you obſerve the Diſtance of the Index from the Meridian it ſelf, you'll have the Æquatorian Diſtance of the Sun from the firſt Meridian; from which the Author ſhews, that the Longitude of the Place may be eaſily diſcover'd.

That, if that Inſtrument be put out of Order by the Motion of the Ship, the alteration of the Air, or otherwiſe, he teaches a Method how to ſet it right again.

Denique ad prædictorum omnium elucidationem brevis quidem, ſed laborioſiſſimus ab auctore compoſitus eſt Tractatus, in quo omnia per Mathematicas demonſtrationes, exempla, & opportunos Trigonometriæ, calculos enucleantur; His additæ ſunt Tabulæ complures ad levandum eorum laborem qui in Trigonometricis calculis expediendis non admodum verſati, facili tamen negotio voti compotes fieri geſtiunt.

In tanto negotio non credit Auctor certiorem ducem inveniri poſſe ipſo Sole, qui conſtanti greſſu Æquatorium iter quotidie abſolvit.

In fine, in order to explain all this, the Author hath compos'd a ſhort and elaborate Treatiſe, wherein he proves his Aſſertions by Mathematical Demonſtrations, Examples, and Trigonometrical Calculations; to which ſome Tables are added, for the Eaſe of thoſe who are not very well skill'd in Trigonometrical Calculations, and whereby however they may eaſily obtain what they deſire.

The Author doth believe, that in ſo weighty a Matter, he cannot follow a truer Guide than the Sun, which every Day by its conſtant Courſe runs round the Globe.

My LORDS and GENTLEMEN,

SINCE I *preſumed to preſent to Your Honours* The Method of Sign^{r} ALIMARI for Diſcovering the LONGITUDE; *I have received from Him ſome other Papers upon the ſame Subject, which I here Humbly ſubmit to Your Honours Judgment; and am with the utmoſt Reſpect,*

My LORDS *and* GENTLEMEN,

Your Honours moſt Obedient,

Humble Servant,

SEBASTIANO RICCI.

St. James's Square,
Septem. the 11th,
MDCCXIV.

Inveniendæ Longitudinis Civitatum, & locorum Univerſi Terraquei Globi vera, & indubitata Methodus DOROTHEI ALIMARI.

QUoniam ſermo noſter ad eos eſt directus, qui in Coſmographiâ, Aſtronomiâ, aliiſque Mathematicis ſunt exercitati, non immorabimur in exponendis rerum terminis, definitionibus, atque principiis, ſed ex abrupto rei ipſius ſubſtantiam aggrediemur.

Primo loco in promptu ſunt habendæ Ephemerides Diurni motûs Solis, & Lunæ in Longitudine exaratæ in gradibus minutis, & ſecundis ad Meridianum Primum, vel alium quemcumque, quem pro Primo haberi cupimus (opus ſemper alicujus diligentiſſimi Aſtronomi, & cum obſervationibus conveniens). Habeantur ſecundo loco diligentiſſimæ Tabulæ Aſcenſionum Rectarum plurium Stellarum Fixarum, inſigniorum, & magis notarum in diverſis Cœli partibus poſitarum, & hæ pariter expreſſæ in gradibus, minutis, atque ſecundis ad tempus obſervationis faciendæ; item Tabulæ Aſcenſionum Rectarum Solis ad ſingulos Eclipticæ gradus pariter in gradibus, minutis, atque ſecundis: Sit & optimum Horologium exprimens tempus diſceſſûs & reditûs alicujus Stellæ fixæ ab uno ad eundem Meridianum in Horis 24, & harum quamlibet in minutis ſexaginta, & horum quodlibet in ſecundis pariter ſexaginta: Sint & in promptu Inſtrumenta propria ad iter Navis quàm certiſſimè fieri poſſit dimetiendum; Habeatur demum & Pyxis Nautica optimâ cuſpide munita: quomodo autem hæc omnia parentur, infrà dicetur.

Hiſce paratis (antequam Sol, vel Luna ad Meridianum loci Obſervationis deveniat) inveniantur eorum Aſcenſiones Rectæ (de more) in gradibus, minutis, atque ſecundis ad ipſorum Luminarium loca in ipſis Ephemeridibus expreſſa in Meridie antecedente, & in Meridie ſubſequente Obſervationem (ſervatâ ſemper in Lunâ latitudine, quam im Meridiano Ephemeridum obtinuerit;) cumque hæ in promptu fuerint, obſervetur Sol, vel Luna in Meridiano Mundi, & eodem temporis momento aptetur Index Horologii ad ipſius Meridianum, & decurrere permittatur (obſervatio Solis interdiù, Lunæ Noctù fieri debet:) expectetur dein adventus alicujus Stellæ fixæ cognitæ ad Meridianum eundem, & momento eodem obſervetur tempus elapſum inter tranſitum Solis, vel Lunæ, & Stellæ per eundem Meridianum, convertaturque (de more) in Gradus, Minuta, atque Secunda Æquatoris, eritque Arcus iſte differentia inter Aſcenſionem Rectam Solis, vel Lunæ, & Stellæ in ipſo Obſervationis Momento; propterea ſi ſubducatur ab Aſcenſione Rectâ Stellæ, nota remanebit Aſcenſio Recta Solis, vel Lunæ, pro ratione ſcilicet eorum alterutrius in Meridiano Obſervati. Hìc duplici ratione uti poſſumus ad inveniendam loci Longitudinem, vel ſcilicet, (adinventæ Aſcenſionis Rectæ operâ) inquirendo loca Solis, vel Lunæ (reſpectivè) in Eclipticâ, aut Zodiaco, eaque conferendo cum eorum locis in Ephemeridibus expreſſis, ut eorum reſultet differentia, quâ mediante, & mediante eorum Planetarum motu diurno in Longitudine, optata loci Longitudo habeatur; vel adinventam Aſcenſionem Rectam Solis vel Lunæ comparando (reſpectivè ſemper) cum eâ, quam in Meridiano Ephemerid[illegible] retinere comperti fuerint, ut earum reſultet differentia. His peractis, (ſubductâ Aſcenſione Rectâ, quam Sol, vel Luna habuerit in Meridie antecedente Obſervationem ab eâ, quam habuerit in Meridie ſubſequente) habebitur motus Diurnus eorum reſpectivæ Aſcenſionis Rectæ, tùmque fiat, ut motus Diurnus antedictus ad integrum Æquatoris Circulum, ita adinventa ſuperiùs differentia ad Arcum Æquatoris interceptum inter Meridianum Primum, ſeu Ephemeridum, & Meridianum loci Obſervationis: Tunc advertendum eſt, an loca Luminarium obſervata, ſive in Longitudine, ſive in Aſcenſione Rectâ ſint minora, æqualia, vel majora exiſtentibus, ſive reſultantibus in Ephemeridibus Meridiei antecedentis; nam ſi minora ſint, ſignum eſt, locum Obſervationis Orientaliorem eſſe Meridiano Primo ſeu Ephemeridum, quo caſu Arcus Æquatoris ſuprà compertus, eſt vera loci Obſervationis Longitudo: Si loca prædicta ſint æqualia, ſignum eſt, Obſervationem factam fuiſſe in ipſo Meridiano Primo, ſive Ephemeridum, quo caſu nulla erit obſervati loci Longitudo: Ubi verò ſunt majora, ſignum eſt, locum Obſervationis eſſe Occidentaliorem Meridiano Primo, quo caſu Arcus Æquatoris ſuprà compertus ſubducendus venit à gradibus 360, quodque remanet eſt vera loci Obſervationis Longitudo numerata à Meridiano Primo verſus Ortum.

Hìc pariter advertendum venit, quòd ſi quis in Obſervatione ipsâ faciendâ non uſus ſit Ephemeridibus conditis ad Meridianum Primum, ſed ad alium quemcumque, notam habere debet ſaltem per Chartas Geographicas bene correctas loci Ephemeridum Longitudinem à Meridiano Primo ſibi bene placito, ut adinventam loci Longitudinem per ejuſdem Additionem, vel Subductionem opportunè corrigere queat.

Ut autem prædicta omnia exemplis à nobis illuſtrentur, duo dabimus exempla; alterum ſcilicet Obſervationis factæ Venetiis in Sole ſub die tertiâ menſis Aprilis Anni 1708, in quâ faciendâ uſi ſumus Ephemeridibus Solarium motuum à nobis conditis ab Anno 1707, ad Annum 1713 ad Kal. Januarij, ad Meridianum Inſulæ Ferreæ, quem pro Primo poſuimus, utentes ipſius Solis Longitudine, & Aſcenſionibus Rectis Stellarum fixarum à nobis pariter Calculo exaratis ad Kal. Januarij Anni 1710; alterum verò exemplum dabimus in Lunâ, quam facimus Obſervatam fuiſſe Biſantij ſub Die 28 Martij Anni 1640, pro qua Obſervatione faciendâ, cum in promptu non eſſent Ephemerides Diurni motûs Lunæ exarat[illegible] Meridianum Primum, placuit nobis uti Ephemeridibus conditis ad tempus prædictum ab Andreà Argolo ad Meridianum Romæ, prout & Tabulis Stellarum fixarum ab ipſo datis ad Kal. Januarij Anni 1640, in quo exemplo, loco Longitudinis ipſius Lunæ, inſervient nobis ejuſdem Aſcenſiones Rectæ, pro quibus exemplis elucidandis ita nos expediemus.

Sit igitur primo loco facta Solis Obſervatio Venetiis ſub Die 3. Aprilis Anni 1708; & quia intentum noſtrum aſſequi intendimus non per Solis Aſcenſiones Rectas, ſed per ejuſdem loca in Eclipticâ (neglectâ Aſcenſionum Rectarum Solis inquiſitione in Meridie antecedente, & in Meridie ſubſequente Obſervationem) ad ulteriora procedemus per loca ejuſdem in Eclipticâ.

Cum igitur ſub Die 3. Aprilis 1708, obſervatus ſit Sol in Meridiano Venetiarum, & (Horologio modo congruo diſpoſito) poſt Horas $9 : 4' : 24'' : 4'''$ in Meridiano eodem obſervatus ſit Regulus, ſeu Cor Leonis; cujus Aſcenſio Recta ex noſtris Tabulis ad idem tempus fuit gr. $148 : 45' : 26''$, converſis propterea Horis $9 : 4' : 24'' : 4'''$ temporis Horarij obſervati inter tranſitum Solis, & Stellæ per eundem Meridianum in Gradus, Minuta, atque ſecunda Æquatoris $136 : 6' : 1''$, ſi ſubducantur hi ab Aſcenſione Rectâ Reguli gr. 148 : 45′ : 26″, remanebit Aſcenſio Recta Solis gr. 12 : 39′ : 20″, quibus in Tabulâ Aſcenſionum Rectarum Solis reſpondere comperiuntur gr. 13 : 45′ : 44″ ſigni Arietis. Hi collati cum Longitudine, quam Sol habuit ipſa Die in Meridiano Primo, ſcilicet Inſulæ Ferreæ, quæ fuit gr. 13 : 51′ : 28″, apparet illico differentia Longitudinum gr. 0 : 5′ : 44″; motus verò Diurnus ejuſdem Diei ex Ephemeridibus ipſis inventus eſt gr. 0 : 58′ : 57″, ſeu Secundorum 3537, quare ſi gr. 0 : 58′ : 57″, ſeu Secunda 3537 dant totum Æquatoris Circulum gr. 360, ſeu Minuta 21600 motus proportionalis gr. 0 : 5′ : 44″, ſeu ſec. 344 dabit pro quæſitâ Longitudine Venetiarum minuta 2100, hoc eſt gr. 35, q. e. d.; Fuit enim locus Solis in Eclipticâ tempore Obſervationis minor loco Solis in eâdem Eclipticâ in Meridie ipſius Meridiani Primi.

Mox exemplum daturi de Lunâ (cum nos ponamus Ephemerides non habere exprimentes motum Lunæ diurnum in ipſo Meridiano Primo) utemur (ad placitum) Ephemeridibus Andreæ Argoli exaratis ad Meridianum Romæ pro inveniendâ Longitudine Conſtantinopolitanæ Urbis, in quâ nos effingimus inter Meridiem Diei 27, & Diei 28 Martii Anni 1641 obſervatam fuiſſe Lunam in Meridiano, & poſt Horas 3 : 27′ : 18″ in eodem Meridiano apparuiſſe inſignem Stellam Azimech, ſeu ſpicam Virginis (inſpectis propterea ante ipſam Obſervationem locis Lunæ in Meridie antecedente, & in Meridie ſubſequente in Zodiaco) ſub Diei 27 Meridie compertam in gr. 13 : 10′ ſigni Leonis cum Latitudine Meridionali gr. 4 : 58′, quibus reſpondet Aſcenſio Recta gr. 134 : 10′, & in Meridie Diei 28 in ipſo Meridiano Romæ viſa eſt obtinuiſſe gr. 25 : 46′, ſigni Leonis cum Latitudine Meridionali gr. 4 : 56′, & Aſcenſione Rectâ gr. 146 : 18′, factâ converſione Horarii Temporis ſupra obſervati Horarum 3 : 27′ : 18″ in Gradus, & Minuta Æquatoris 51 : 49′ : 22″, hiſque ſubductis ab Aſcenſione Rectâ ſpicæ Virginis, quæ (ex eodem Argolo) ad Annum 1640 fuit gr. 197 : 33′, remanent pro Aſcenſione Rectâ Lunæ gr. 145 : 43′ : 37″ ⅓, qui collati cum Aſcenſione Rectâ Lunæ in Meridie Diei 28 Martij prædicti, erit eorum differentia gr. 0 : 34′ : 22″ ⅔, motus verò Diurnus Aſcenſionis, qui habetur ex ſubductione Aſcenſionis Rectæ Diei 27 ab Aſcenſione Rectâ Diei 28, cum inventus ſit gr. 12 : 8′, ſeu Minut. 728, ſi propterea fiat, ut motus Diurnus Aſcenſionis Min. 728 ad integrum Æquatoris Circulum gr. 360, ſeu Minut. 21600, ita differentia ſupra inventa gr. 0 : 34′ : 22″ ⅔ ad quartum, aderit quarto loco Longitudo Conſtantinopolitanæ Urbis quæſita Minutorum $1019\frac{2}{3}$, hoc eſt gr. 16 : 59' : 40" à Meridiano Romæ numerata verſus Ortum ; cui, ſi addantur Gradus Longitudinis Romæ à Meridiano Inſulæ Ferreæ ex Mappis Sanſonianis comperti in ſummâ gr. 35, aderit integra Conſtantinopolis Longitudo à Meridiano Primo, ſcilicet Inſulæ Ferreæ graduum 51 : 59' : 40", q. e. d.

Quod de Ephemeridibus Andreæ Argoli nos fecimus, fieri reſpectivè poteſt de aliis quibuſcumque ad alium quemlibet Meridianum ordinatis tam pro Sole, quàm pro Lunâ, modò illæ ſint exactiſſimæ, & Obſervationibus conſonantes.

Hæc, ſi adamuſſim ſerventur, cum Mathematicas habeant in promptu demonſtrationes, Experimentis pariter confirmari poterunt ; verùm, quia huic Praxi, quam nos expeditam eſſe intendimus, plurimæ obeſſe videntur difficultates, eas nos reſolvere conabimur.

Difficultates nonnullæ in Longitudinis inveniendæ Praxi, ut ſupra, quæ ſint, & quomodo reſolvantur.

PLurima in hac Praxi obeſſe videntur, quæ operationem ipſam non modicis difficultatibus involutam oſtendunt. Prima difficultas conſiſtit in Horologio Æquinoctiali inveniendo, quod adamuſſim diſceſſum, & reditum Stellæ ab uno ad eundem Meridianum dimetiatur in partes æquales, ſeu Horas 24, quarum quælibet diviſa intelligatur in portiunculas Sexaginta, & harum quælibet in alias Sexaginta portiunculas, & in ejuſdem Horologij congruo uſu. Secunda difficultas conſiſtit in determinando Meridiano, in quo Obſervationes ſunt faciendæ. Tertia, motus Navis de loco ad locum cum Meridiani mutatione non tam de facili Praxim ipſam admittens. Quarta difficultas conſiſtit in cognitione Stellarum fixarum, & comparatione exactiſſimæ earum Aſcenſionis Rectæ. Quinto, & poſtremo loco difficultas in inveniendâ Itinerariâ diſtantiâ, ſeu itinere Navis cum differentiâ Longitudinis inter duo loca, in quibus faciendæ ſunt Obſervationes: quibus Objectionibus reſpondere eas diluturi non dubitabimus. Primæ Objectioni circa Horologium exactiſſimum comparandum, quod adamuſſim metiatur tempus diſceſsûs unius Stellæ ab uno Meridiano, & reditûs ad eundem in partes æquales, ſeu Horas 24, quarum quælibet diviſa ſit in partes 60, & harum quælibet aliis ſexaginta conſtet particulis, reſpondemus, reverà horarium tempus computari debere, habito reſpectu ad motum Stellarum fixarum, non verò Solis, vel alterius Planetæ, qui aliquanto tardiùs ad eundem perveniunt Meridianum, quàm Stellæ fixæ pro ratione eorum motûs in ordine ſignorum: Attamen, ſi tale nobis Horologium deficeret, alio quocumque uti nobis licebit (modò id æqualibus temporibus conſtanter æqualia metiatur ſpatia, alioquin illud omnino rejicietur :) ante tamen, quàm eo utamur, experimentum capiemus, obſervando ſcilicet diſceſſum, & reditum unius Stellæ ab eodem ad eundem Meridianum, quot ſcilicet Horis, Minutis, atque ſecundis Horologii noſtri adamuſſim expleatur in diverſâ Aeris, & motûs Navis conſtitutione, & hoc ipſo Horologio utemur in Obſervatione temporis Horarii, ut ſuprà, quod (aureâ juvante regulâ) corrigemus. Exempli gratiâ, ſi obſervatus ſit Periodus Stellæ in datâ aliquâ Aeris Conſtitutione confici intra Horas 23 : 30', horarium verò tempus ſit h. 5 : 15', ſic operabimur. Si h. 23 : 30' Horologij noſtri dant Horas Æquinoctiales, hoc eſt Sydereas 24, quid dabunt h. 5 : 15' Horologij noſtri? & dabunt tempus Horarium æquatum Horarum 5 : 21' : 42", ſeu gr. 79 : 32' : 48" ſubducendos ab Aſcenſione Rectâ Stellæ in ſimili datâ Aeris Conſtitutione. Idem operabere (reſpectivè referendo,) ſi tempus diſceſsûs, & reditûs Stellæ exceſſerit h. 24 Horologij noſtri, & oppoſitæ difficultati proviſum remanebit: Hoc tamen utiq; ſervandum venit, ut Horologium ipſum æqualibus temporibus conſtantiſſimè æqualia metiatur ſpatia, & tanto melius judicatur, ſi per plures Dies curſum ſuum abſolvat eodem curſûs, tenore licèt ſufficiat illud per Horas duodecim tantùm ſine ſenſibili alteratione decurrere; advertendum autem, ut utamur eodem in ſimili Aeris conſtitutione, reſpectivè ſemper referendo.

Quoad ſecundam difficultatem, quo ſcilicet in Meridiano faciendæ ſint Obſervationes Luminarium, & fixarum, pleno ore fatemur, optimum fore, ſi illæ fiant in Meridiano Vero, ſcilicet Mundi; in eo enim terminantur Aſcenſiones eorum Rectæ, non verò in Meridiano Magnetico: Nos tamen pro certo habemus, quòd validè poſſint ipſæ Obſervationes fieri etiam in Meridiano Magnetico, modò Magnetica Declinatio ſenſibilem non experiatur de loco ad locum variationem; neque enim alia intercedere poteſt differentia, quàm in eo, quòd portiuncula Aſcenſionis Rectæ debita gradibus magneticæ Declinationis nonnihil citiùs à Stellâ menſuretur, quàm à Luminaribus, ob eorum Diurnam retardationem in perveniendo ad eundem Meridianum; alioquin certum eſt (poſitâ æquali Magneticâ declinatione) horarium tempus à Meridiano vero ad Meridianum verum æquale ſemper eſſe horario à Meridiano magnetico ad Meridianum magneticum: quare ſine errore notabili in Magnetico non ſecus, ac in Meridiano vero obſervationes fieri valent, horariumque tempus reditûs Stellæ fixæ ad Meridianum magneticum ſubductum ab Aſcenſione Rectâ Stellæ, Aſcenſionem Rectam veram ipſius Luminaris in reſiduò gignere, modò & Luminare & Stella in eodem magnetico obſerventur Meridiano; ad tollendas tamen omnes ſcrupuloſitates ope Ortivarum, vel Occiduarum Latitudinum, bonum erit Nautas diebus ſingulis Magneticam obſervare declinationem, ut præciſè Meridianus ipſe, in quo faciendæ ſunt obſervationes, habeatur: & hoc circa ſecundam difficultatem.

Tertiæ Difficultati, quomodo ſcilicet agendum ſit, ſi inter duas faciendas Obſervationes, Luminaris ſcilicet, & Stellæ, Navis iter facere cogatur, reſpondetur, aut Navis ab Auſtro ad Boream, vel à Borea ad Auſtrum procedit, & his caſibus, cum Navis non mutet Meridianum, nihil ultra prædicta venit faciendum; procedente verò Navi ad Ortum, obſervandum, quam per quartam, ſeu Rhombum procedat, & per Inſtrumenta propria ad hunc uſum explorandum venit iter per Navim inter utramque obſervationem emenſum, & differentia Longitudinis elicienda in gradibus, minutis, atque ſecundis Æquatoris, illaque venit addenda tempori horario inter utramque obſervationem decurſo, & aderit horarium tempus æquatum ab Aſcenſione Recta Stellæ ſubducendum; procedente verò Navi ad Occaſum, differentia Longitudinis, ut ſupra inventa ſubducitur horario tempori, ut ſuprà, ut illud æquatum habeatur ab Aſcenſione Rectâ Stellæ ſubducendum.

Placet hic nobis exemplum præbere in obſervatione per nos factâ Venetijs, ut ſuprà à nobis expoſitâ, ſupponamuſque Navim noſtram poſt obſervatum Solem in Meridiano proceſſiſſe Ortum verſus per Rhombum, ſeu quartam, quam Tranſmontanæ Nationes appellant *ſudeſt*, nos verò Itali vocamus *Oſtro Sirocco*, & intrà Horarium tempus emenſum inter obſervationem Solis, & Stellæ abſolviſſe Milliaria Italica quinquaginta, ad inveniendam differentiam Longitudinis inter hæc data duo Loca obſervationum, fiat primò, ut ſinus totus ad Milliaria quinquaginta, ut ſuprà emenſa per Navim, ità ſinus gr. 22. 30′. hoc eſt Anguli Meridiani cum quartâ Oſtro ſirocco, ad Milliaria Italica decem, quibus receſſit Sol à Meridiano Venetiarum verſus Ortum; his dein in Parallelo, ad quem Navis devenit (de more operando) reſpondere comperiuntur minuta quatuordecim Æquatoris, quæ (navi procedente verſùs Ortum) addita tempori horario, ut ſuprà obſervato, horarum 9. 11′. 45″. 4‴, hoc eſt gr. 136. 31′. 1″. conſtituent horarium tempus æquatum graduum 136. 45′. 1″. ſubducendum ab Aſcenſione Rectâ Reguli, quæ ad tempus obſervationis ex noſtris Tabulis fuit gr. 148. 45′. 26″, & remanet Aſcenſio Recta Solis gr. 12. 0′. 25″, cum quibus operabimur, ut ſuprà factum eſt, ſingula ſingulis reſpectivè referendo.

Quartæ difficultati, quæ duas continet partes, hoc eſt, quomodò imperitiores Nautæ Stellas fixas, earum nomina, & ſitum cognoſcere queant, & quomodò earum Aſcenſiones Rectas ipſimet adamuſſim comprehendere valeant, ita reſpondemus.

Quoad Primam, indiget Nauta noſter Cœleſti Globo quantum fieri poterit maximo, in quo Aſteriſmi, & imagines omnes, quæ habentur tam in Zodiaco, quàm extrà, ſive ad Boream, ſive ad Auſtrum ſint diligentiſſimè delineati, atque diſpoſiti, cum Stellis fixis in eorum quolibet contentis, prout revera in Firmamento conſpiciuntur, earumque (ſaltem præcipuarum) nominibus, atque Magnitudine diſtinctis : huic Globo Nautica Pyxis ſit annexa, cujus Meridiana Linea vel ſit in Plano Meridiani ipſius Globi, vel illi Parallela.

Hunc Globum Nauta noſter ſtatuet in Plano aliquo Horizonti Naturali Parallelo, & in loco aperto (potiùs ſolido, & immobili, quàm mutanti, & mobili) cum elevatione Poli congruâ loco obſervationis, & in Plano Meridiani Mundi Loci obſervationis, noctu dein quâlibet horâ, exempli gratiâ, horâ tertiâ noctis, accedens Globo ſuo, ut ſuprà diſpoſito, circumgyrabit illum donec Locus in Eclipticâ, in quo Sol die illâ reperiebatur, Horizontem Occiduum præciſè inſideat, tunc obſervans gradum Æquatoris ex ipſâ Occidentali parte ſe ſecante, cum Horizonte eodem Globum ſuum gyrabit, quouſque ſub Horizontem deſcendant alij gradus 45 Æquatoris, (totidem enim debentur horis tribus noctis) & habebit Globum ſuum conſtitutum juxta poſitum Cœli, & Mundi eâdem horâ : obſervatis dein Aſteriſmis in Meridiano ipſo, vel prope in Globo ſuo deſcriptis cum Stellarum Figuris, & nominibus in ipſo Globo notatis, è regione ipſis in Firmamento reſpondente obſervabit Stellas fixas, quarum nomina, ſitum dextrum, vel ſiniſtrum, antecedentem, ſubſequentem, vel medium, aut in ipſâ Aſteriſmi parte poſitum diſtinctè ex ipſius Globi inſpectione cognoſcet ; inde circumgyrans Globum ſuum (prout horæ creverint) eâdem Methodo ſuccedentes Meridiano Stellas diligentiſſimè obſervans plures per Noctes, & diverſis Anni temporibus, uberem Stellarum ipſarum fixarum notitiam ſibi comparabit. Quâ autem ratione Nauta noſter, etſi minus in Aſtronomiâ verſatus, Stellarum fixarum Aſcenſiones Rectas exactiſſimè habere queat (etſi in Triangulis Sphæricis ſupputandis, ut cæteri Profeſſores facere conſueverunt, non admodum ſit edoctus) ita ſe expediet.

Primo loco habeat in promptu Ephemerides alicujus boni Aſtronomi, & in Meridie ejus diei, in quâ Aſcenſionem Rectam Solis habere voluerit, obſervet motum Solis Diurnum in Longitudine : habeat dein cognitam differentiam Longitudinis inter Meridianum Loci obſervationis, quam elicere poterit vel ex ipſis Ephemeridibus, (ſolent enim Ephemeridum conditores eam in Tabulis Civitatum exarare) vel ex Chartis Geographicis benè correctis : hiſce comparatis, per Regulam Auream fiat, ut totus Æquatoris Circulus gr. 360, ſeu min. 21600 ad motum Solis Diurnum in Longitudine habitum, ut ſuprà ex ipſis Ephemeridibus, ita differentia Longitudinis ſuprà comperta ad partem proportionalem dicti motûs ſubducendam à Loco Solis in meridie Ephemeridum (ſi Locus obſervationis fuerit Orientalior) addendam, ſi fuerit Occidentalior, Meridiano Ephemeridum, & conſurget vera Solis Longitudo in gradibus, minutis, atque ſecundis, cum quâ in Tabulâ Aſcenſionum Rectarum Solis (de more) ejus Aſcenſio Recta comparari poterit in gradibus, minutis, atque ſecundis : in hoc autem operator debet eſſe ſollicitus, ut hæc Solis Aſcenſio Recta, prout & ſequentes Stellarum fixarum obſervationes, fiat in Meridiano vero Mundi, & in ſolo ſtabili, non autem in Navi, ne minimus aliquis error in obſervatione interveniat : Obſervato Sole in Meridiano, illicò Horologio ſuo Æquinoctiali, velut ſupra diximus, opportunè diſpoſito, attendet adventum alicujus Stellæ fixæ ad eundem Meridianum, & illicò obſervato diligentiſſimè tempore horario decurſo, illud convertet in gradus, minuta, & ſecunda Æquatoris, & addet inventæ Aſcenſioni Rectæ Solis, & ex aggregato conſurget Aſcenſio Recta Stellæ quæſita.

Habitâ unius Stellæ fixæ Aſcenſione Rectâ, facili negotio aliarum omnium Aſcenſiones Rectæ comparari poterunt ; ſi enim Stella cognita minorem in Zodiaco Longitudinem obtinuerit incognitâ, obſervabitur in Meridiano Stella cognita cum tempore horario decurſo uſque ad adventum Stellæ incognitæ ad eundem Meridianum, hocque addito reſpondere comperiuntur minuta quatuordecim Æquatoris, quæ (navi procedente verſùs Ortum) addita tempori horario, ut ſuprà obſervato, horarum 9. 11′. 45″. 4‴, hoc eſt gr. 136. 31′. 1″. conſtituent horarium tempus æquatum graduum 136. 45′. 1″. ſubducendum ab Aſcenſione Rectâ Reguli, quæ ad tempus obſervationis ex noſtris Tabulis fuit gr. 148. 45′. 26″, & remanet Aſcenſio Recta Solis gr. 12. 0′. 25″, cum quibus operabimur, ut ſuprà factum eſt, ſingula ſingulis reſpectivè referendo.

Quartæ difficultati, quæ duas continet partes, hoc eſt, quomodò imperitiores Nautæ Stellas fixas, earum nomina, & ſitum cognoſcere queant, & quomodò earum Aſcenſiones Rectas ipſimet adamuſſim comprehendere valeant, ita reſpondemus.

Quoad Primam, indiget Nauta noſter Cœleſti Globo quantum fieri poterit maximo, in quo Aſteriſmi, & imagines omnes, quæ habentur tam in Zodiaco, quàm extrà, ſive ad Boream, ſive ad Auſtrum ſint diligentiſſimè delineati, atque diſpoſiti, cum Stellis fixis in eorum quolibet contentis, prout revera in Firmamento conſpiciuntur, earumque (ſaltem præcipuarum) nominibus, atque Magnitudine diſtinctis: huic Globo Nautica Pyxis ſit adnexa, cujus Meridiana Linea vel ſit in Plano Meridiani ipſius Globi, vel illi Parallela.

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Habitâ unius Stellæ fixæ Aſcenſione Rectâ, facili negotio aliarum omnium Aſcenſiones Rectæ comparari poterunt; ſi enim Stella cognita minorem in Zodiaco Longitudinem obtinuerit incognitâ, obſervabitur in Meridiano Stella cognita cum tempore horario decurſo uſque ad adventum Stellæ incognitæ ad eundem Meridianum, hocque addito

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Aſcenſioni Rectæ Stellæ, conſurgit Aſcenſio Recta Stellæ incognitæ : ubi verò Stella cognita majorem habuerit in Zodiaco longitudinem incognitâ, ſubducetur horarium tempus ab Aſcenſione Rectâ Stellæ cognitæ, & aderit Aſcenſio Recta Stellæ incognitæ quæſita.

Sit,exempli gratiâ,cognita Aſcenſio Recta Aldebaran,quæ ex noſtris Tabulis ad Kal. Januarii 1710 eſt gr. 64. 51'. 25", quæraturque Aſcenſio Recta Capitis Meduſæ minorem in Zodiaco Longitudinem habentis; factâ primum obſervatione Meduſæ in Meridiano vero, inde temporis horarij decurſi, quod ponitur fuiſſe hor. 1. 33'. 48". quibus reſpondent gradus Æquatoris 23. 27'. 11". ſi hi ſubducantur ab Aſcenſione Rectâ Aldebaran gr. 64. 51'. 25". aderit Aſcenſio Recta Capitis Meduſæ graduum 41. 24'. 25".

Quæro indè Aſcenſionem Rectam Sirij majorem in Zodiaco Longitudinem habentis, quàm Aldebaran : hanc primò obſervo in Meridiano,indè tempus horarium decurſum,quod fuit hor. 2'. 14'. 12". ſeu gr. Æquatoris 33. 33, hos addo Aſcenſioni Rectæ Aldebaran gr. 64. 51'. 25". & conſurgit Aſcenſio Recta Sirii gr 98. 24'. 25". Eodem modo operabimur in cæteris, & facili negotio voti compotes erimus ; ſufficiet autem harum Stellarum magis notarum, & variis in Globi partibus diſpoſitarum Aſcenſiones rectas comparatas habere.

Quinta difficultas, quæ verſatur in inveniendâ itinerariâ diſtantiâ, emerſâ ex motu Navis de prioris obſervationis loco ad locum ſecundæ, etſi in rigore Geometrico plures contineat difficultates in ejus Praxi, attamen eam etiam Nautæ minus periti propè præter cognoſcere pluribus modis, & Inſtrumentis, ac etiam per Solis motum,& poſitum rectificare didicerunt,adeo ut ſuperfluum ducamus ulteriùs inſtruere Minervam ; agitur enim de tritâ Praxi, navigantibus omnibus paſſim notâ.

Demum Nautam Lectorem hujus compendioli noſtri monitum volumus, ut diligentiſſimis, atque correctiſſimis utatur Ephemeridibus, & Tabulis ; atque in obſervandis tum Luminaribus, tum Stellis fixis præciſè in Meridiano, tum in horario tempore computando, aliiſque ſupputationibus ineundis maximâ utendum eſſe diligentiâ, non neglectis ſecundis, multò minus & minutis ; unius enim ſecundi neglectio in obſervationibus faciundis ſupputationes ipſius Longitudinis conſiderabiliter augere, vel minuere valet; quæ diſcretus, & prudens Nauta per ſe comprehendere, & corrigere valebit.

FINIS.

Figura Prima.

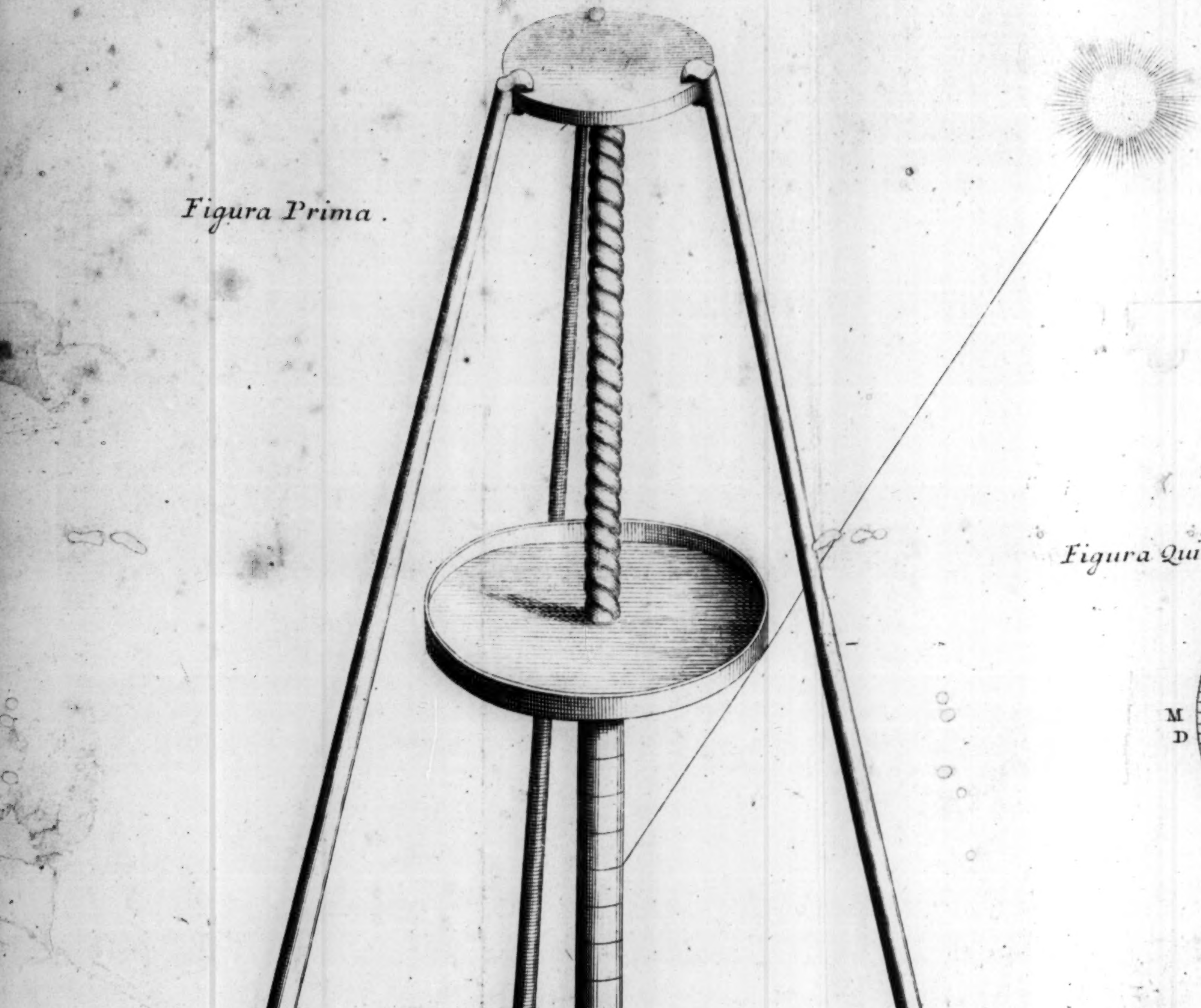
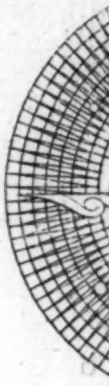


Figura Quinta.



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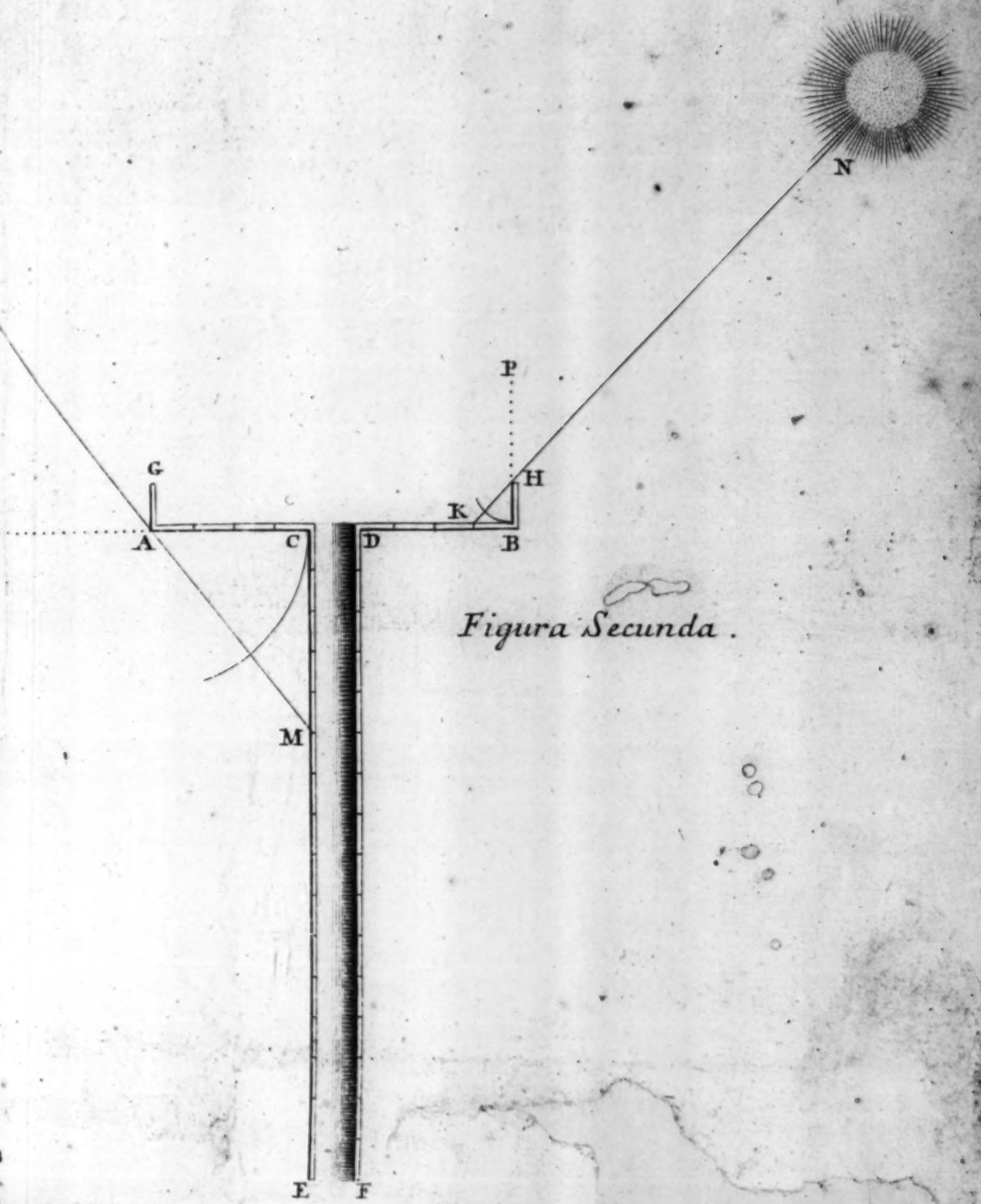
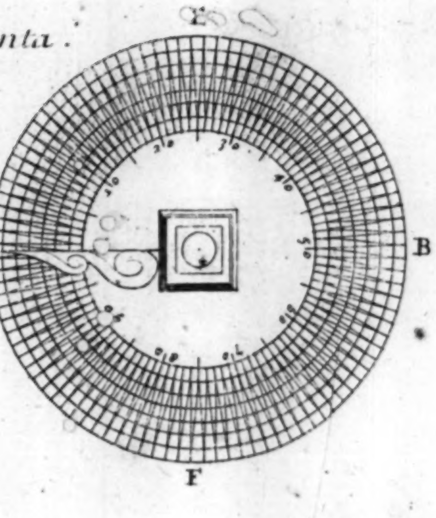


Figura Secunda .



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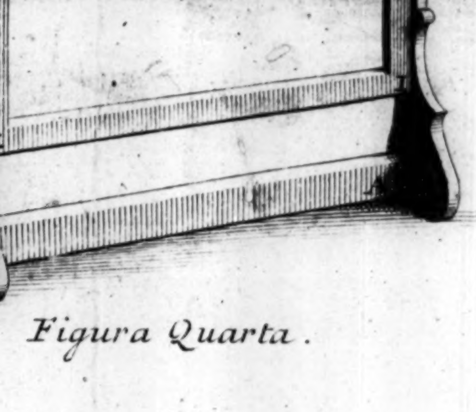
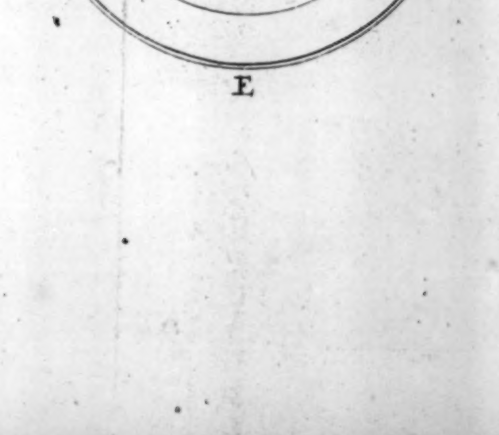


Figura Quarta .



to face

Plate

* * *

The annexed Figures ſhew the Conſtruction of the Inſtrument for obſerving the exact Altitude of the Sun.

Figure 1. THE Inſtrument ſuſpended on a three-footed Frame.

Fig. 2. Shews the External Form of the Inſtrument, *viz.* The Diameter of the Braſs Circle; the Height of the thin Plate fixed round about it; and the thickneſs and length of the Tube.

A B. The Diameter of the Braſs Circle divided into Parts, or into Nine Inches.

C D. The Thickneſs of the Hole of one Inch in the middle of the ſaid Circle.

CA,

Figuræ adnexæ Expoſitæ Methodi facilitatem, & Demonſtrationem exhibent, ut & Inſtrumentorum ſtructuram ad Solis Altitudinem exactè Inveniendam.

Figura I. E*XHIBET deſcriptum Inſtrumentum tripedali fulcro ſuſpenſum.*

Figura Secunda *exprimit exteriorem ipſius Inſtrumenti formam, ſcilicet Diametrum Circuli ærei, Altitudinem laminæ illi circumpoſitæ, & Tubi Craſſitiem, & Longitudinem.*

A B. Diameter Circuli ærei diviſus in partes, ſeu uncias Novem.

C D. Craſſities foraminis unciæ unius in Medio circuli ejuſdem.

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C A, D B. The other Part of the Semidiameter of the Circle divided into four Inches.

A G, B H. The thin Plate fixed round the Circle at a right Angle, whoſe Height A G, B H, is one Inch.

C E, D F. The Length of the Hole divided into ſixteen Parts, or Inches, whoſe Thickneſs C D, or E F is one Inch.

L A M. The Ray of the Sun, which ſtriking upon the thin Plate at the Point A, marks the Length of the Shadow upon the Tube in M. It ſhews upon the Tube it ſelf the ſhorteſt Length of Shadow C M, whoſe Gnomon is C A parallel to the Horizon, whoſe Centre A is ſuppos'd in the Centre of the Univerſe, and the Length of the Gnomon A C is underſtood to be divided into four Inches, whereof each is of 25,000 ſmall Parts, and the whole of 100,000. The Gnomon, or Radius A C being ſuppos'd of 100,000 ſmall Parts, the Radius is in lieu of the Tangent, and therefore the Length of the ſame Shadow being known in the ſmall Parts, whoſe Gnomon A C is of 100,000, by the Table of Tangents, the very Length C M will ſhew the Angle C A M in Degrees, Minutes, and Seconds: For this Angle is equal to the Angle O A L, which is the Altitude of the Sun above the Horizon.

C A, D B. Reliquus Circuli Semidiameter diviſus in partes, ſeu uncias Quatuor.

A G, B H. Lamina Circulo circumpoſita ad Angulum rectum, cujus Altitudo A G, B H eſt unciæ unius.

C E, D F. Longitudo Tubi diviſa in partes, ſeu uncias ſexdecim, cujus Craſſities C D, ſeu E F eſt unius unciæ.

L A M. Radius Solaris, qui percutiens in Laminam in puncto A, ſignat Longitudinem Umbræ ſupra Tubum in M, oſtendit ſupra Tubum ipſum Longitudinem breviorem Umbræ C M, cujus Gnomon eſt C A parallelus Horizonti; hujus autem vertex A ſupponitur in Centro Univerſi, & Longitudo Gnomonis A C intelligitur diviſa in uncias quatuor, quarum qualibet eſt partiuncularum 25000, *& in integro, ſunt partes* 100,000. *Poſito autem Gnomone, aut Radio A C eſſe partium* 100,000 *umbra C M Locum tenet Tangentis; Ideoque cognitâ ejuſdem Umbræ Longitudine in partiunculis, quarum Gnomon A C eſt* 100,000 *in Tabulis Tangentium ipſa Longitudo C M. indicabit Angulum C A M in gradibus, minutis, & ſecundis; Ipſe enim Angulus æqualis eſt Angulo O A L, qui eſt Altitudo Solis Supra Horizontem.*

The Line NHK, which repreſents the Ray of the Sun ſtriking upon the thin Plate BH, caſts the Shadow of the Vertex of the Gnomon H at the Point K, and makes the Triangle HKB, in which BH is the Length of the Gnomon, which is mark'd to be 100,000 Parts; tho' it be really but 25,000.

BK the Length of the Shadow, which is inſtead of a Tangent at the Angle KHB, equal to the Angle NHP, which marks the Diſtance of the Sun from the Vertex, or Complement of the ſaid Angle, which is the required Altitude of the Sun. However, becauſe the Gnomon BH is mark'd 100,000 Parts, and is only of 25,000, the Length of the Shadow BK, which is the Tangent of the Angle BHK, ſhall be found with it thus quadrupl'd in the Table of Tangents; and is the requir'd Diſtance of the Sun from the Vertex, or Complement of the Altitude of the Sun in Degrees, Minutes, and Seconds.

Fig. 3. The Deſcription of the flat Braſs Circle, with the Concentrick Circles.

A. The Hole of one Inch, which is to be fill'd up by the Thickneſs of the Tube. The Concentrick Circles, diſtant one Inch from each other, are to Meaſure the Length of the Shadows caſt upon the Gnomon HB of the

Linea autem NHK, quæ figuratur pro Radio Solari percutiens ſupra Laminam BH, projicit umbram verticis Gnomonis H in puncto K, & fit Triangulus HKB, in quo BH eſt Longitudo Gnomonis, quæ figuratur partium 100,000 *quamvis re verâ ſit tantum partium* 25000.

BK Longitudo umbræ, quæ tenet Tangentis locum ad Angulum KHB æqualem angulo NHP, qui figurat diſtantiam Solis à vertice, ſeu complemento ipſius Anguli, quod eſt Altitudo Solis deſiderata. Attamen quia Gnomon BH figuratur partium 100,000 *& tantum ſit* 25000, *quadruplicatâ etiam Longitudine umbræ BK, quæ tangens eſt Anguli BHK, reperiettur cum ipſâ quadruplicatâ in Tabulis Tangentium Angulus BHK, qui eſt diſtantia Solis à vertice, ſeu complemento Solaris Altitudinis quæſitæ in gradibus, minutis, & ſecundis.*

Figura Tertia, *eſt Circuli ærei plani deſcriptio, cum Circulis concentricis.*

A. Foramen Craſſitiei unius unciæ, quod occupari debet Craſſitie Tubi. Circuli concentrici ſinguli æquo ſpatio unius unciæ diſtantes inſerviunt ad dimetiendam Longitudinem umbrarum projectarum à Gnomone HB, qui reperitur the ſecond Figure, which being quadrupl'd as before, give the Tangent of the Angle of the Sun's diſtance from the Vertex.

B C, D E. The thin Plate of the Height of one Inch, which is round the Braſs Circle. Every Interval between the Concentrick Lines is underſtood to be divided into 25,000 Parts, as above.

Fig. 4, 5. Denote an Inſtrument to meaſure the Length of one Inch divided into 25,000 Parts.

A B, C D. The Frame, whoſe Sides A B, C D are to be about the Height of 2½ Inches, and of a larger, or leſſer Thickneſs, as the Diameter of the Circle B E, D F muſt be either bigger or leſſer. The two Sides A B, C D, muſt be ſo hollow'd inwardly, that another Frame G H, I K may be fix'd to it, and mov'd either upwards or downwards. At the Point L a Screw of about one Inch and a half long, muſt be ſo fix'd, that it may paſs through the Centre of the Circle B E, D F. This Screw ought to have in the Length of one Inch 25 Turns, ſo that it will be convenient, that the 25 Turns ſhould be adapted to one Inch. However, it matters not whether this Length be longer or ſhorter, provided the Inches deſcrib'd upon the ſaid Inſtrument be of the ſame Length, namely of 25 Turns

peritur in ſecundâ Figurâ; quæ quadruplicatæ, ut ſupra dictum eſt, dant Tangentem Anguli diſtantiæ Solis à vertice.

B C, D E. Lamina Altitudinis unciæ unius, quæ circumdat Circulum æreum. Unum quodque enim intervallum Lineis Concentricis interpoſitum intelligitur diviſum in 25,000 *partes, ut ſupra.*

Quarta & Quinta Figura *exhibent Inſtrumentum ad dimetiendam Longitudinem unciæ unius diviſæ in partes* 25,000

A B, C D. Cancellus, cujus Latera A B, C D, ſint Altitudinis circiter unciarum 2½, *Latitudinis autem majoris aut minoris, ſicuti Diameter Circuli B E, D F major, aut minor deſideretur. Duo Latera A B, C D ſint interius excavata, ita ut illi adaptari poſſit alius cancellus G H, I K, & ſuperius inferiusque moveri poſſit. In puncto L, figenda eſt Cochlea Longitudinis circiter unciæ unius, & Dimidiæ, quæ tranſire poſſit per Centrum Circuli B E, D F. Hæc Cochlea in Longitudine unciæ unius ſpiras habeat viginti quinque, unde bene erit Longitudinem unciæ accommodatam eſſe ſpiris prædictis* 25; *Nihil enim refert unciæ menſuram longiorem, aut breviorem eſſe, modò unciæ in prædicto inſtrumento delienatæ ſint omnes ejuſdem Longitudinis, nempe Altitudinis* 25 *ſpirarum. Circulus B E,*

See *Fig.* 5. Turns. The Circle B E, D F, is to be internally and externally divided into 100 Parts or Degrees, and each Degree to be divided after *Tycho Brahe*'s Method into Ten Parts, by the concentrick and equal diſtant Circles.

Fig. 5. The whole Circle divided into 1000 Parts. The Diviſions upon the Circle ought to be placed ſo, that they begin (as at M) from a Line drawn from the Center of the Circle to the Circumference; from this Line let the Matrix of the Screw be apply'd to the Turn of the Screw, let an Index be annex'd, and the internal Frame ſo diſpoſed, that the extremity of the Turn be exactly equal to the Plane of the Index; let the Index be fitted to the beginning of the Diviſions of the Circle in it, ſo that it may always be moved upon the Plane of the ſame Circle.

An Inſtrument being thus made, let the Length of the Shadow be meaſur'd with the moſt exact, and ſharpeſt Compaſſes, and afterwards let the Index and the Matrix of the Screw annex'd to it be turn'd round. In every turning round of the Index into the Circle, each Turn will ſhew one of the 25,000 Parts, into which the Inch is divided, and the Index will ſhew upon the Circumference of the

B E, D F in interiori, & exteriori diviſus eſſe debet in partes, ſeu gradus 100, *& eorum quilibet diviſus modo Tychonico in partes Decem, ope circulorum decem æqui-diſtantium, & concentricorum, ut exprimit*

Figura Quinta; *Ita ut totus Circulus diviſus ſit in partes* 1000. *Principium diviſionum ſupra Circulum exiſtentium aptari debet; ubi Spira, ſive uncia incipit, ita ut Linea, quæ à centro Cochleæ, ſive circuli eſt principium Spiræ, protenſa ſupra circulum indicet earum diviſionum principium, inde cochleæ matrix apponatur ſpiræ, cui annexus ſit Index, & ita Cancellus internus diſpoſitus ſit, ut extremitas ſpiræ ſit Indicis plano ad amuſſim æqualis. Index autem aptetur principio diviſionum circuli in M, & ita ſit Index ipſe diſpoſitus, ut ſemper moveri poſſit ſuper ipſius circuli planum.*

Inſtrumento tali modo compoſito, circino perfectæ, & acutiſſimæ cuſpidis umbræ Longitudo dimetiatur; poſtea Index cui annexa eſt cochleæ matrix circumvolvatur. In ſingulâ Indicis circumactione in circulo, ſingula exibit ſpira, nempe mille partes de 25000, *in quibus diviſa eſt uncia, earumque mille partium quot exitæ ſint, Index ipſe in Circuli prædicti circumferentiâ ſignabit. Exempli gratiâ, umbræ Longi-*

the Circle how many of the 1000 Parts are come up. The Length of the Shadow being meaſur'd with a Pair of Compaſſes, let it be apply'd exactly to the Point of the Screw appearing above the Index: For Inſtance, ſuppoſe Eleven Turns are rais'd, and the Index points out of the Circumference of the Center 713 Parts, the Length of the Shadow will thence be found to be 11,713, which in the Table of Tangents will give Deg. 6.: 40′: 52″: for the Angle anſwering to the Shadow it ſelf. But if the Length of the Shadow be Five Inches Three Turns, and 156 Parts of a Thouſand, the Tangent will be 128,156, which Number in the Table of Tangents will give Deg. 52: 2′: 7″.

But if the Length of the Shadow cannot be exactly taken with the Points of the Compaſſes, the remaining Part may be meaſur'd, and by proper Subſtractions the true Length will reſult; for care muſt be taken, that Shadows be meaſur'd with the greateſt Accuracy poſſible, that their true Longitude by the help of this Inſtrument may be obtained, that the true Tangent may be found.

THE END.

Longitudo circino dimenſa portioni Cochleæ, extra Indicem exitæ, in puncto æquali applicetur. Exitæ ſint exemp. gr. ſpiræ undecim integræ, & Index in circuli circumferentiâ ſignet partes 713, reſultat Longitudinem umbræ eſſe partium 11713, quæ in Tabulis Tangentium dabunt gradus 6: 40′: 52″ pro Angulo ipſi umbræ oppoſito. Quòd ſi umbra eſſet Longitudinis unciarum quinque, ſpirarum trium & partium milleſimarum 156, Tangens erit 128156, cui Numero in Tabulis Tangentium reſpondent gradus 52: 2′: 7″.

Verùm ſi umbræ Longitudo haud exactè circini cuſpide ſuſcipi poſſit, reſiduum dimetiatur, & congruâ ſubtractione præciſum reſultet. Hoc enim advertendum eſt, umbras ſemper quam poſſibili accuratione dimetiendas eſſe, ut Inſtrumenti hujus Ope earum ſcrupuloſa Longitudo habeatur, ut vera Tangens reſultet.

FINIS.

ERRATA.

PAGE 4. in the *Latin*, Line 29. read *Circuli* inſtead of *Globi*; and in the *Engliſh*, *Circle* inſtead of *Ball*.